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BRIDGING THE GAP BETWEEN SCIENCE AND PRACTICAL APPLICATIONS

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Content

Foreword

Message from Editor-in-Chief

It is our great pleasure to publish the Second Volume of the *Sports Therapy Journal*. First and foremost, we would like to express our sincere gratitude for your valuable contributions and continued support.

Unlike traditional journals that place emphasises heavily on the dissemination and discussion of basic or applied research findings, the STJ focuses on the practical applications of sound scientific principles and evidence from the literature. Sports therapists play a pivotal role in prescribing advanced exercise programmes for sports rehabilitation, injury prevention, health promotion, and the correction of dysfunction. In particular, the integration of strength and conditioning into sports therapy practice enables more sport-specific and functional adaptations. Our mission extends beyond providing remedies for injured athletes; our practitioners are committed to applying scientific yet innovative approaches to enhance individuals' resilience to fatigue and injury.

To comprehensively support the medical and wellness needs of athletes from diverse backgrounds, a team-based approach is essential. Such collaboration allows athletes to benefit from the expertise of various medical and healthcare professionals. In order to strengthen multidisciplinary practices, we actively promote the collaboration and professional connections with physiotherapists, osteopathic practitioners, strength and conditioning coaches, and other healthcare providers. We strongly believe that sports medicine in Hong Kong will continue to grow through the collective efforts, and we anticipate the contribute to the global development.

We look forward to your continued engagement, and to welcoming you to this platform for exchange of knowledge in the near future.

Testimonial

From THEi to the National Team Ivy's Journey as a Sports Therapist

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> Being a Sports Therapist is not merely a profession,
> It is a responsibility I hold deeply.

Hello everyone, my name is Yi Nok Lui, and I am a Sports Therapist.

Following my graduation from the Technological and Higher Education Institute of Hong Kong (THEi) in 2016, I began my professional journey in Sports Therapy. Over the years, I have had the privilege of working with the medical teams of Hong Kong Rugby, the Guangdong Artistic Gymnastics Team, the China Artistic Gymnastics Team, the Shandong Rugby Team, and currently the China Women's Rugby Team. Along the way, I have been honoured to support national athletes and even Olympic champions during training and competition.

Looking back on this journey, I have come to realise that being a Sports Therapist is not merely a profession, it is a responsibility I hold deeply.

Working in environments where Sports Therapists are emerging, it is a common misconception that we provide no more than massage, taping, and rehabilitation exercises. However, a Graduate Sports Therapist is much more than that. From what I see, an outstanding Sports Therapist would possess four essential qualities: skilfulness, logic, compassion, and effective communication.

A Pair of Skilful Hands

A Sports Therapist's hands are one of the most important tools we have. Whether assessing an injury, delivering manual therapy, or applying prophylactic taping, every intervention requires technical competence developed through years of practice and experience.

When I started my career, I was eager to learn as many techniques as possible, believing that the more skillsets I acquired would make me a better practitioner. However, over time, I realised that success is not determined by how many techniques you know, but how precise and effective your techniques are used. By your ability to identify the primary cause and apply just the right solution at the right time, techniques can often be simple but effective.

A Logical Mind

Sports injuries are rarely caused by a single factor. As Sports Therapists, we often work like detectives, analysing training loads, movement patterns, physical function, and lifestyle factors to understand the root cause of an issue and develop the most appropriate treatment plan.

In recent years, much of my work has been in rugby, a high-impact contact sport where athletes frequently experience traumatic injuries, joint injuries, and concussions. From pitch-side emergency care and Head Injury Assessments (HIA) to return-to-play decision-making, every step requires sound clinical reasoning and professional judgment.

In many cases, our role extends beyond treating an injury. We are helping to safeguard an athlete's career, long-term health condition, and overall well-being.

A Compassionate Heart

Injuries are more than physical challenges to athletes, particularly elite level whose value, opportunities, even identity are dependent on their sporting success. Injuries can greatly affect their confidence, motivation, and future aspirations.

Throughout my career, I have worked with athletes who were devastated by missing major competitions and many more others who struggled through lengthy rehabilitation processes. During these down moments, they often need more than physical treatment alone, yearning for understanding, encouragement, and support. These experiences have taught me the importance of empathy.

As Sports Therapists, we are not only treating injured body parts; we are helping people to regain strength and to rebuild confidence for their future endeavours.

The Ability to Speak in Plain Language

Communication is another essential part of our profession. Every day we interact with athletes, sports coaches, strength and conditioning coaches, and doctors. The most advanced medical knowledge has little value if it cannot be understood by the people who needed it.

For this reason, I have always tried to translate complex medical concepts into practical and accessible languages. Effective communication helps athletes understand their injuries, enables coaches to make informed decisions, and supports collaborations within a multidisciplinary team.

Today, I still consider myself a lifelong learner. Sports medicine continues to evolve, and new knowledge emerges everyday. Looking ahead, I wish to continue the development of my expertise in sports trauma, concussion management, and athlete welfare; and, of course, supporting more athletes in achieving their goals.

My journey from THEi to the national team has taught me that the true value of a Sports Therapist lies not only in helping athletes recover from injury, but also in helping them pursue their dreams. It has been an honour to be part of that journey.

Time passes quickly. From the classrooms of THEi to the training grounds of national teams, many things have changed. What remains unchanged is my commitment to learning, my respect for the profession, and my responsibility to the athletes I serve.

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Case Report

Case Report: Multi-disciplinary Collaboration and Load Management in the Upper Extremity Reconditioning of a Collegiate Contemporary Dancer Following a Distal Radius Fracture

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Abstract

A 22-year-old female year-2 contemporary dance student sustained a right distal radius fracture. Following six weeks of conservative cast immobilisation, radiographic imaging confirmed bone callus formation. Upon cast removal, she exhibited wrist joint stiffness, restricted range of motion, diminished muscular strength, reduced grip capacity, and restricted wrist joint distraction.

A 12-week sports physical therapy program was initiated in partnership with an institutional Dance Science Team's Fit to Train strength and conditioning framework. Interventions combined physical modalities (ultrasound, contrast baths), manual therapies (Mulligan's Mobilisation with Movement), and a staged, closed-kinetic-chain loading regimen. Periodized athletic programming preserved general fitness without overloading the healing radius. By week 12, the patient achieved symmetry in AROM and restored her baseline grip strength and demonstrated an unassisted vertical handstand.

Initiating an on-site, specialised sports rehabilitation framework allowed the student to begin structured care without prolonged delay. Applying a behavioural graded exposure model based on quantifiable tissue mechano-transduction and load management principles safely transitioned a post-immobilisation wrist back to inverted loading. However, late-stage transient pain spikes remind clinicians that structural remodelling continues beyond standard discharge criteria.

Keywords: *Wrist Fracture, Contemporary Dance, Floor-Work, Multi-Disciplinary, Graded Exposure, Load Management, Mechano-Transduction, Dance Medicine.*

Key points: *Applying a graded exposure model based on progressive wrist angles and strength and conditioning training allows a post-fracture wrist to safely adapt from modified, multi-point kneeling to full vertical axial bodyweight loading.*

1. Introduction

In modern contemporary dance — a genre that combines classical ballet lines with floor-based acrobatics, rapid changes of momentum, and partnering work across all three planes of motion. The upper extremity is rapidly shifted from an open-loop, non-weight-bearing state to a closed-loop, closed-kinetic-chain, weight-bearing state (Russell, 2013). Because rapid, high-velocity transitions into and out of the floor are required, functions of landing contact are served by the hand–wrist complex, through which structural vectors that often exceed the dancer's total body weight must be absorbed, transferred, and propelled (MacDonald & Heinen, 2025; Panebianco & Resmini, 2025). As a result, extra demands are placed on the cortical integrity of the distal radius and its associated intercarpal ligaments due to intense axial compression and multi-directional shear torque (MacDonald & Heinen, 2025). Consequently, a specific profile of upper extremity conditions is frequently reported in the epidemiologic dance science literature, most notably acute wrist sprains and carpal instability caused by high handstand compression forces, as well as wrist impingement syndrome resulting from repeated extreme hyperextension (Russell, 2013). When control is lost during a floor slide or roll, the shock-absorbing mechanism is compromised. As a result, impact forces are shifted away from the muscles and directly onto the bones and ligaments of the wrist joint, and bone fractures may therefore occur.

This case report outlines the 12-week rehabilitation of a 22-year-old contemporary dance student with a conservatively managed distal radius fracture. A non-operative protocol combining clinical manual therapy with a collaborative Fit to Train strength and conditioning program. The report evaluates the clinical progression, functional milestones, and transient complications encountered during the transition from post-cast immobilisation to full floor-work and inverted handstand loading.

Tissue Mechano-transduction

When a non-displaced distal radius fracture is sustained by a performing artist and a period of rigid joint immobilisation is undergone, standard therapeutic goals centred on restoring basic open-chain active range of motion (AROM) for activities of daily living (ADLs) are considered fundamentally inadequate for athletic reconditioning (Beleckas & Calfee, 2017). Specialised stimulation via tissue mechano-transduction is required for the biological reorganisation of post-immobilisation bone tissue—the physiological pathway by which mechanical forces are sensed by cellular structures and converted into intracellular biochemical signals to drive cellular remodelling (Khan & Scott, 2009). Following six weeks of cast immobilisation, newly synthesised collagen fibres are deposited in a random, cross-linked, disorganised extracellular matrix, and severe capsular and tendinous hypo-mobility is clinically presented (Chamberlain et al., 2009). If the tissue is completely unloaded due to over-protection, protein synthesis is down-regulated by the lack of mechanical stress, and persistent arthrofibrosis, tendon degradation, and regional bone demineralisation are consequently caused (Houglum, 1992). Conversely, localised shear stress and tensile deformation are created through the application of structured, incremental mechanical force, by which the disorganised matrix is disrupted and cellular integrins and stretch-activated ion channels are activated (Khan & Scott, 2009). Through this biochemical cascade, collagen type I synthesis is up-regulated, and cortical bone consolidation is accelerated by local fibroblasts and osteoblasts, and the repairing structural architecture is aligned directly along the functional lines of athletic stress (Bornstein et al., 2021; Hernandez-Bule et al., 2021).

Graded Exposure Framework

The transitional pathway from post-cast immobilisation to the demanding forces of contemporary floor-work is characterised by complex biological and psychological challenges. Lower structural thresholds are often demonstrated by highly sensitive post-fracture tissues, while protective neuromuscular guarding, heightened movement-related apprehension, and explicit kinesiophobia are frequently exhibited by the central nervous system (Kaur & Zeppieri, 2026). Acute inflammatory exacerbations are frequently provoked, or secondary avoidance behaviours are triggered that disrupt movement kinematics. To address this safely, an evidence-based clinical strategy is offered by a behavioural graded exposure framework (Vlaeyen et al., 2001). Rather than an immediate return to high-risk inverted balancing being forced, complex choreographic actions are broken down into simple, adjustable, and measurable mechanical tasks within this model (Macedo et al., 2012). By systematically increasing loading in handstand weight-bearing loading, wrist-hand angle, weight distribution, and dynamic movement within a pain-monitored boundary, controlled mechanical stress can be applied to the tissue while the threat response of the nervous system is rewritten, and protective apprehension is successfully replaced with functional motor confidence (Kaur & Zeppieri, 2026).

Multi-disciplinary Collaboration in Load Management Integration

Maximising the recovery trajectory of a collegiate student-artist requires a structured, multi-disciplinary collaboration that bridges clinical exercise therapy and athletic performance reconditioning (VanEtten et al., 2021). True load management cannot be achieved in isolation within an outpatient clinical setting only; it requires an active collaboration with institutional dance science teams, strength and conditioning coaches, and departmental choreographers (Russell, 2013). Implementing performance frameworks Fit to Train program allows student to optimise the periodised artist programming, maintaining core stability and lower-limb metabolic volume using hand-free training blocks while the upper limb completes the early structural healing (Russell, 2013). This shared communication pipeline ensures that external choreographic volume and internal joint tolerance are continuously aligned, tracking real-time symptom data and performance metrics to guide a structured transition back to unmodified professional workloads (Gabbett, 2016; Soligard et al., 2016).

2. Case Presentation

Case Background

A 22-year-old female student was enrolled in the contemporary dance department of a professional performing arts institute. Participation in rigorous technical dance training lessons five times per week was required by her demanding academic curriculum. An unremarkable past medical history was reported, with no macro-trauma, surgeries, or chronic musculoskeletal injuries noted in the right wrist, forearm, or upper extremity.

After a closed right distal radius fracture was sustained by the student. Following immediate medical evaluation at a hospital, conservative management through standard cast immobilisation for six weeks was implemented; surgical fixation was not indicated due to maintained anatomical alignment and cortical stability. After six weeks, formation of an intact bone callus across the fracture site was confirmed by follow-up radiographic evaluation, with no structural displacement or joint surface instability observed.

An orthopaedic referral to an outpatient physical therapy department, with an anticipated two-week waiting period, was issued to the student. To facilitate immediate monitoring and seamless integration within her academic schedule, attendance at her institute's physiotherapy clinic was initiated from the institute. At the baseline assessment following cast removal, global stiffness of the right wrist joint, localised pain during movement, and functional apprehension were presented. Utilisation of a supportive wrist brace for all standard ADLs was reported. Prior to data collection for the publication of this case report, written informed consent was obtained from the student.

Treatment and Intervention

A comprehensive 12-week institutional rehabilitation program was commenced by the student three days following her objective clinical evaluation, consisting of a total of 12 weekly on-site physical therapy sessions synchronised with a specialised multi-disciplinary conditioning protocol. An active partnership was established with the Dance Science Team, certified strength and conditioning coach, and departmental choreographer. Load management and performance preservation were regulated through the institution's structured Fit to Train program, which allowed physical training modifications to be precisely coordinated with injury healing timelines.

To optimise regional blood circulation, relieve severe post-immobilisation capsule stiffness, and manage local fluid volume, therapeutic physical modalities—including local ultrasound and contrast hydrotherapy were applied directly across the right radio-carpal joint line. During the application of these physical modalities, only a mild, comfortable warmth with zero joint pain was reported by the student. The specific treatment area was located via precise manual palpation of the distal radius anatomical structures where localised fracture tenderness and soft-tissue tightness were present.

The restorative framework was divided into three distinct chronological phases based on tissue healing and functional presentation: Phase 1 (Local Activation and Mobility), Phase 2 (Graded Mechanical Loading), and Phase 3 (Performance Integration). Manual therapies, including wrist joint distraction & glides and Mulligan's Mobilisation with Movement (MWM) using sustained accessory glides, were performed by the clinician. Concurrently, progressive weight-bearing demands were introduced through closed-kinetic-chain exercises to stimulate bone and soft tissue mechano-transduction. The detailed protocol and exercise program are outlined in Table 1

To ensure complete accountability and cross-disciplinary tracking, a communication group was formed with all the professional parties and was updated with weekly progress from the Dance Science Team, physical therapy clinic, and departmental choreographers. This shared communication channel was utilised by the multidisciplinary team to continuously exchange the student's real-time injury status, specific training progression, and demanding academic schedule. By aligning these clinical and performance variables, a highly responsive load-management network was established, ensuring that the student was rehabilitated safely and effectively throughout the entire academic semester without disrupting her curriculum requirements (Gabbett, 2016; Russell, 2013).

Table 1 – Integrated Physiotherapy, "Fit to Train" Program and Choreography Modification Across Phases.

Rehabilitation Phase & Goals	Physiotherapy Interventions & Manual Therapy	Fit to Train & Choreographic Modifications	Progression Criteria
Phase 1: Local Activation & Mobility *(Weeks 1–2)* **Primary Goals:** • Reduce residual post-cast oedema • Restore basic open-chain pain-free ROM • Prevent systemic deconditioning	• **Modalities:** Pulsed ultrasound (1.0 MHz, 1.2 W/cm², 20% duty cycle for 8 minutes) across the distal radius fracture line. • **Manual Therapy:** Gentle Grade I–II passive radio-carpal and mid-carpal distraction glides to alleviate joint stiffness. • **Clinical Exercises:** Sub-maximal wrist isometric contractions (flexion, extension, radial/ulnar deviations) performed at neutral angles (10-second holds, 5 sets), waiter hand table with 1 kg Theraball/weight plate, wrist AROM exercises.	• **Choreography Modification:** Total modification of technique classes; complete ban on right upper extremity weight-bearing or high-demand gripping maneuvers. • **Strength & Conditioning:** Hands-free cardiovascular volume via upright stationary cycling (30 mins); lower-limb muscle strength preservation via bodyweight goblet squats, farmer walk, dumbbell lunges, and unweighted lunges; core stabilisation via supine deadbugs, Russian twist and abdominal crunches.	• Intact cortical bone callus confirmed on radiographs. • Resolution of resting pain (NRS 0/10). • Pain-free tolerance of basic open-chain active wrist movements.
Phase 2: Graded Mechanical Loading *(Weeks 3–7)* **Primary Goals:** • Clear capsular extension blocks	• **Manual Therapy:** MWM by applying a sustained manual posterior-anterior (PA) glide during active wrist extension; instrument-assisted fascial cupping along tight forearm flexor and pronator fascial line. • **Clinical Exercises:** Close-kinetic-chain sagittal weight-shifting against a clinical treatment table (NRS <= 2/10); 4-point quadruped kneeling declined holds on a towel to reduce extreme wrist	• **Choreography Modification:** Partial re-integration into non-weight-bearing standing marking classes; zero permission for floor falls, rolls, or partnering work. • **Strength & Conditioning:** Right upper limb reconditioning using isolated resistance machines; selection includes machine chest press, seated machine mid-row, machine shoulder press, and cable lat pulldowns.	• Symmetrical active wrist flexion and complete restoration of pronation/ supination symmetry. • Close kinetic chain 4-point quadruped loading tolerated on a flat floor

• Initiate early closed-chain mechano-transduction • Restore baseline grip capacities	extension angles; progressive hand-grip dynamometer squeezing drills.	Resistance is strictly scaled from 9.1 kg up to 18 kg for 3 sets of 10 repetitions, ensuring joint stress remains within strict pain-free boundaries (NRS < 3/10). Lower-limb progressions include weighted Bulgarian squats and dumbbell Romanian deadlifts.	without sharp pain spikes. • Right hand-grip strength increased to a minimum of 25 kg.
Phase 3: Performance Integration *(Weeks 8–12)* **Primary Goals:** • Maximise multi-directional shear tolerance • Recondition dynamic handstand mechanisms • Complete return-to-dance sequencing	• **Modalities:** Local contrast hydrotherapy baths (alternating hot and cold water immersion) applied immediately post-training to accelerate local metabolic recovery and clear transient fluid accumulation. • **Manual Therapy:** MWM with distraction of wrist to optimise dynamic joint play. • **Clinical Exercises:** Straight-arm floor planks; advanced chair-planks with feet elevated 45 cm to simulate handstand loading angles; dynamic multi-directional floor hand-walking drills; high-frequency plyometric ball dribbling against a trampoline to retrain eccentric forearm shock-absorption capabilities; Progression from Foot elevated handstand to full handstand as progression.	• **Choreography Modification:** Gradual return to specialised contemporary technique classes; structured practice of floor-entry slides, rolls, and inverted handstand entries with controlled speed. Partnering lifts are introduced with strict weight limits under the direct supervision of departmental choreographers. • **Strength & Conditioning:** Upper limb machine chest press and rows are advanced to a high-volume target of 27 kg for 10 repetitions; inclusion of single-arm overhead dumbbell presses scaled up to 12 kg. Upper limb plyometric training are re-introduced to match competitive dance demands.	• Right active wrist extension restored to full symmetry. • Right hand-grip strength fully restored to the pre-injury baseline value of 28 kg. • Unassisted >10-second vertical handstand successfully executed without any support. • Able to attend full dancing schedule

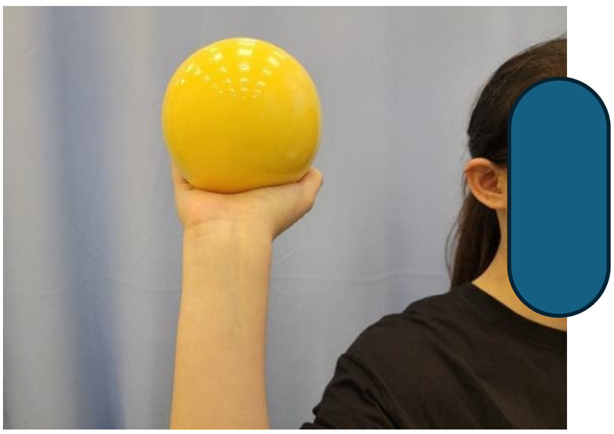


Figure 1 & 2 – Waiter hand table with weighted ball (Left) and weight Plate (Right).

Figure 3 – Dumbbell farmer walk.

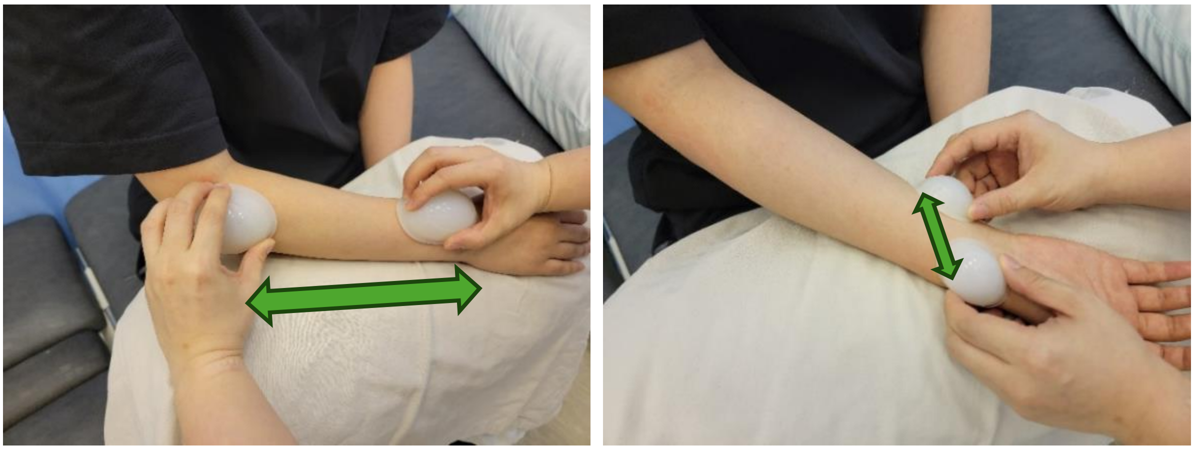

Figure 4 & 5 – Fascial cupping on wrist extensor (left) and pronator (right) with the arrow indicating the gliding direction.

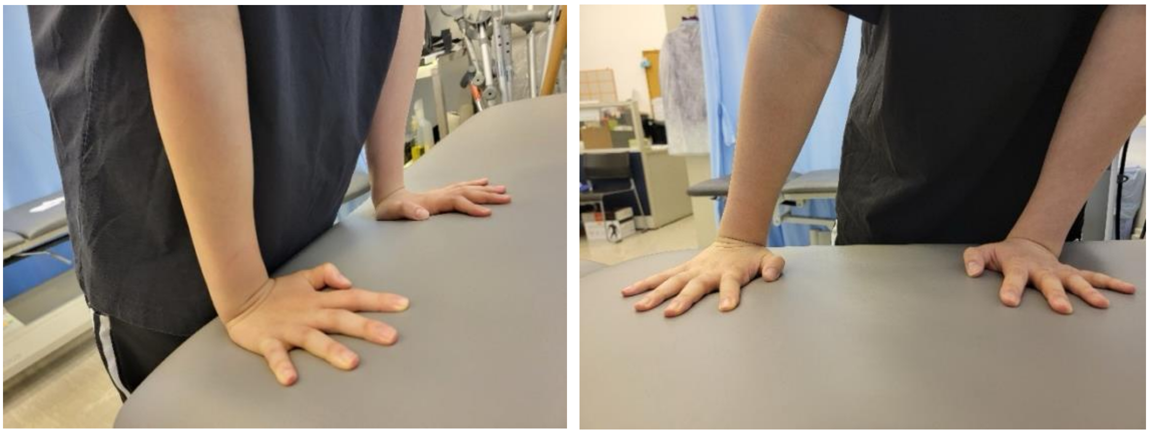

Figure 6 & 7 – Sagittal (left) and coronal (right) weight shifting with hands on treatment table.

Figure 8 & 9 – 4-point kneeling declined hold on a towel (left) and progression with knee off the mat (right).

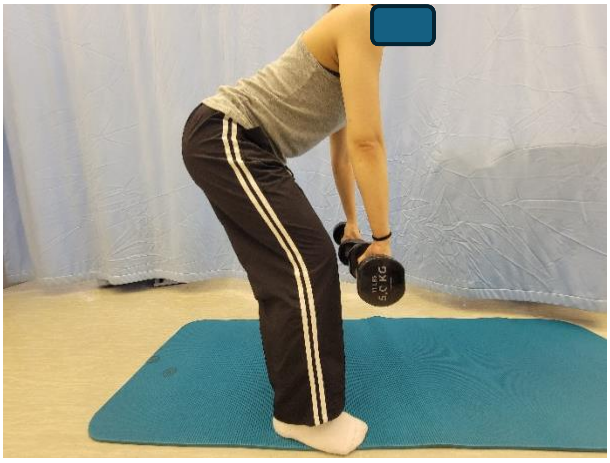

Figure 10 – Dumbbell Romanian deadlift.

Figure 11 – Trampoline ball dribbling.

Figure 12 – Inchworm walkout.

Figure 13, 14 & 15 – Straight arm hand elevated plank hold (left), on the floor (middle), foot elevated (right).

Figure 16 – Straight arm plank sideway walkout.

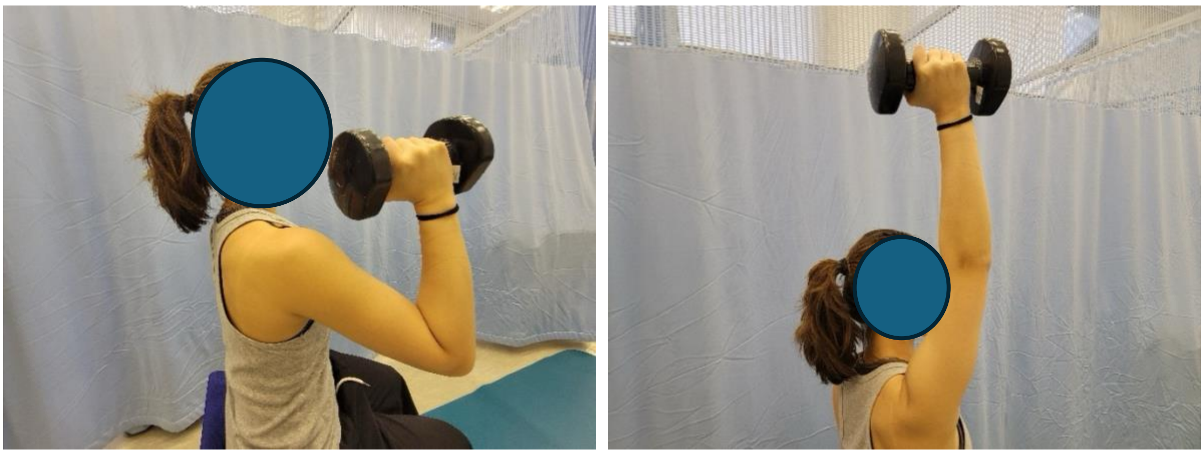

Figure 17 – Single arm overhead dumbbell press.

Figure 18 – Foot elevated handstand hold.

3. Result

Patient outcomes were systematically assessed using the Numeric Pain Rating Scale (NRS) for localised pain intensity, goniometric measurements for active right wrist extension, flexion, and deviations, hand-grip dynamometry for quantitative strength, and anatomical wrist circumference for local oedema tracking. During each weekly session, the NRS and AROM were measured. Joint play testing and wrist circumference measurements were conducted at regular intervals to monitor fluid changes and carpal distraction quality. Regarding pain intensity, active open-chain movements demonstrated an early reduction in pain by Week 2. Closed-kinetic-chain loading was tolerated with minimal pain during table weight-shifting in Weeks 3 and 4, but advanced to higher levels of local discomfort when progressive straight-arm planks and dynamic hand-walking drills were introduced during Weeks 6 and 8. A significant pain spike occurred during a small live performance in Week 9, registering acute distress during a pushing manoeuvre executed through direct dancer-to-dancer body contact. Notably, the technical dance arrangement had been strictly modified to eliminate all floor-pressing and partnering lift sequences to prevent radius overloading. This transient neural reaction resolved rapidly without subsequent joint swelling or residual inflammatory symptoms by the next day, indicating an appropriate structural response to acute mechanical stress under load (Gabbett, 2016). Active wrist joint range showed a distinct, asynchronous recovery pattern across anatomical planes. Active wrist extension showed steady improvement from its restricted post-immobilisation baseline, rising consistently through the vector staging phase and achieving full range of motion symmetry relative to the uninjured side by Week 11. Active wrist flexion reached full range of motion (FROM) ahead of extension, completely clearing its pathomechanical limitations by Week 4. Ulnar deviation successfully cleared its initial restriction to match the contralateral limb's full capacity by Week 5. Furthermore, active supination rapidly cleared its severe initial lag to achieve full structural symmetry by Week 2, while active pronation achieved complete symmetry by Week 5. Quantitative hand-grip strength increased consistently over the rehabilitation period, rising from initial post-cast measurements taken in Week 4 to fully restore her non-injury baseline of 28 kg (data given from fitness screening data in Dance Science Team). Anatomical wrist circumference measurements confirmed that local fluid accumulation was successfully managed, demonstrating a steady stabilisation down to match the uninjured side by Week 11 following targeted contrast hydrotherapy and lymphatic clearance protocols. Patient compliance with the prescribed physical therapy interventions and the collaborative Fit to Train program was closely monitored across the semester. During each clinical session, adherence was verified through direct verbal questioning and joint reviews with the institutional Dance Science Team via the professional party communication group. Total compliance with all independent conditioning parameters was reported by the patient, which directly contributed to her overall objective progression and successful academic return. Table 2 further illustrates the step-by-step weekly progression of active joint ranges, gross grip strength, and progressive wrist weight-bearing tolerance across the therapeutic timeline. Furthermore, the dynamic relationship between wrist extension AROM and structural adaptations in wrist extensor strength is illustrated in Figure 19.

Table 2 – Integrated Weekly Tracking of Active Joint Range, Strength, and Functional Stressor Pain Scores

Timeline Milestone	**Active Joint Range** **(Non-injured side: Extension 89°, Flexion 73°, Pronation/Supination Symmetrical FROM)**	**Grip Strength** **(Non-injured side: 28 kg)**	**Wrist Circumference** **(Non-injured side: 15.0 cm)**	**Average pain level in wrist joint range of motion**	**Wrist Weight-Bearing Progression & Functional Stressor Pain Scores** **(NRS 0–10)**
Baseline *(Admission)*	• Extension: 30° *(Dorsal pulling)* • Flexion: 40° *(Distal radius pain)* • Pronation & Supination: 90° Lag	N/A *(Immobilised)*	15.5 cm *(Local oedema)*	NRS 4/10 *(Flexion limit)*	All weight-bearing patterns contraindicated due to immobilization constraints.
Week 1 *(Phase 1)*	• Extension: 42° *(Firm stiffness)* • Flexion: 47° *(Tendon pulling)* • Pronation & Supination: 60° Lag	N/A *(Unweighted)*	15.4 cm	NRS 3/10 *(End-range only)*	Closed-kinetic-chain activities contraindicated; unweighted therapeutic open-chain tracking initiated.
Week 2 *(Phase 1)*	• Extension: 55° *(Capsular stretch)* • Flexion: 60° *(Reduced ache)* **• Pronation & Supination: Symmetrical FROM**	N/A *(Unweighted)*	15.4 cm	NRS 2/10 *(Extension limit)*	Restoration of basic transverse plane symmetry; axial loading remains contraindicated.

Week 3 *(Phase 2)*	• Extension: 80° *(Capsular stretch)* • Flexion: 63° *(Dispersed pain)* • Pronation & Supination: Symmetrical FROM	N/A *(Machine tasks)*	15.3 cm	NRS 1/10	• **Straight-Arm Knee Plank:** NRS 2/10 *(performed on a declined towel wedge to reduce full extension angles)*. • Advanced planking configurations remain restricted.
Week 4 *(Phase 2)*	• Extension: 80° *(Joint stiffness)* • **Flexion: 73° (Symmetrical FROM)** • Pronation & Supination: Symmetrical FROM	24 kg *(Injured baseline)*	15.3 cm	NRS 0/10	• **Straight-Arm Knee Plank:** NRS 2/10 *(advanced to a flat tabletop surface)*. • Advanced planking configurations remain restricted.
Week 5 *(Phase 2)*	• Extension: 84° *(Reduced pinching)* • Flexion: 73° *(FROM, pain-free)* • Pronation & Supination: Symmetrical FROM	25 kg	15.3 cm	NRS 0/10	• **Full Planking Pattern:** NRS 4/10 *(initiated on standard floor surfaces with modified knee-assist options)*. • Dynamic hand-walking drills remain restricted.
Week 6 *(Phase 2)*	• Extension: 84° *(Persistent block)* • Flexion: 73° *(FROM, pain-free)*	26 kg	15.2 cm	NRS 0/10	• **Full Planking Pattern:** NRS 3/10 *(advanced to a full standard toe-lever alignment)*. • Dynamic hand-walking drills remain restricted.

	• Pronation & Supination: Symmetrical FROM				
Week 7 *(Phase 2)*	• Extension: 84° *(Persistent block)* • Flexion: 73° *(FROM, pain-free)* • Pronation & Supination: Symmetrical FROM	26 kg	15.2 cm	NRS 0/10	• **Full Planking Pattern:** NRS 1/10. • **Foot-Elevated Box Plank:** NRS 5/10.
Week 8 *(Phase 3)*	• Extension: 84° *(Extension block)* • Flexion: 73° *(FROM, pain-free)* • Pronation & Supination: Symmetrical FROM	27 kg	15.2 cm	NRS 0/10	• **Foot-Elevated Box Plank:** NRS 3/10 *(introduced alongside with early multi-directional dynamic hand-walking drills*. • **Vertical Handstand Hold:** NRS 3/10 *(box-assisted with feet elevated at 45 cm)*.
Week 9 *(Phase 3)*	• Extension: 84° *(Post-perf. soreness)* • Flexion: 73° *(FROM, pain-free)* • Pronation & Supination: Symmetrical FROM	27 kg	15.2 cm *(Contrast Therapy applied)*	NRS 0/10	• **Foot-Elevated Box Plank:** NRS 3/10. • **Vertical Handstand Hold: NRS 6/10** *(transient neural and mechanical pain spike during a small live performance pushing maneuver)*.
Week 10 *(Phase 3)*	• Extension: 86° *(Stiffness clearing)*	27 kg	15.1 cm	NRS 0/10	• **Foot-Elevated Box Plank:** NRS 1/10.

	• Flexion: 73° *(FROM, pain-free)* • Pronation & Supination: Symmetrical FROM				• **Vertical Handstand Hold:** NRS 2/10 *(executed in a wall-supported layout; post-performance irritation successfully clearing as reported from the departmental choreographer)*.
Week 11 *(Phase 3)*	**• Extension: 89° (Symmetrical FROM)** • Flexion: 73° *(FROM, pain-free)* • Pronation & Supination: Symmetrical FROM	**28 kg** ***(Symmetrical baseline)***	**15.0 cm** ***(Oedema cleared)***	NRS 0/10	• **Foot-Elevated Box Plank:** NRS 0/10. • **Vertical Handstand Hold:** NRS 1/10 *(tolerated during unassisted dynamic handstand entries)*.
Week 12 *(Discharge)*	• Extension: 89° *(Symmetrical FROM)* • Flexion: 73° *(FROM, pain-free)* • Pronation & Supination: Symmetrical FROM	28 kg *(Symmetrical baseline)*	15.0 cm *(Oedema cleared)*	NRS 0/10	• **Vertical Handstand Hold: NRS 0/10** *(mild structural discomfort reported only at the termination of a sustained 10-second hold)*.

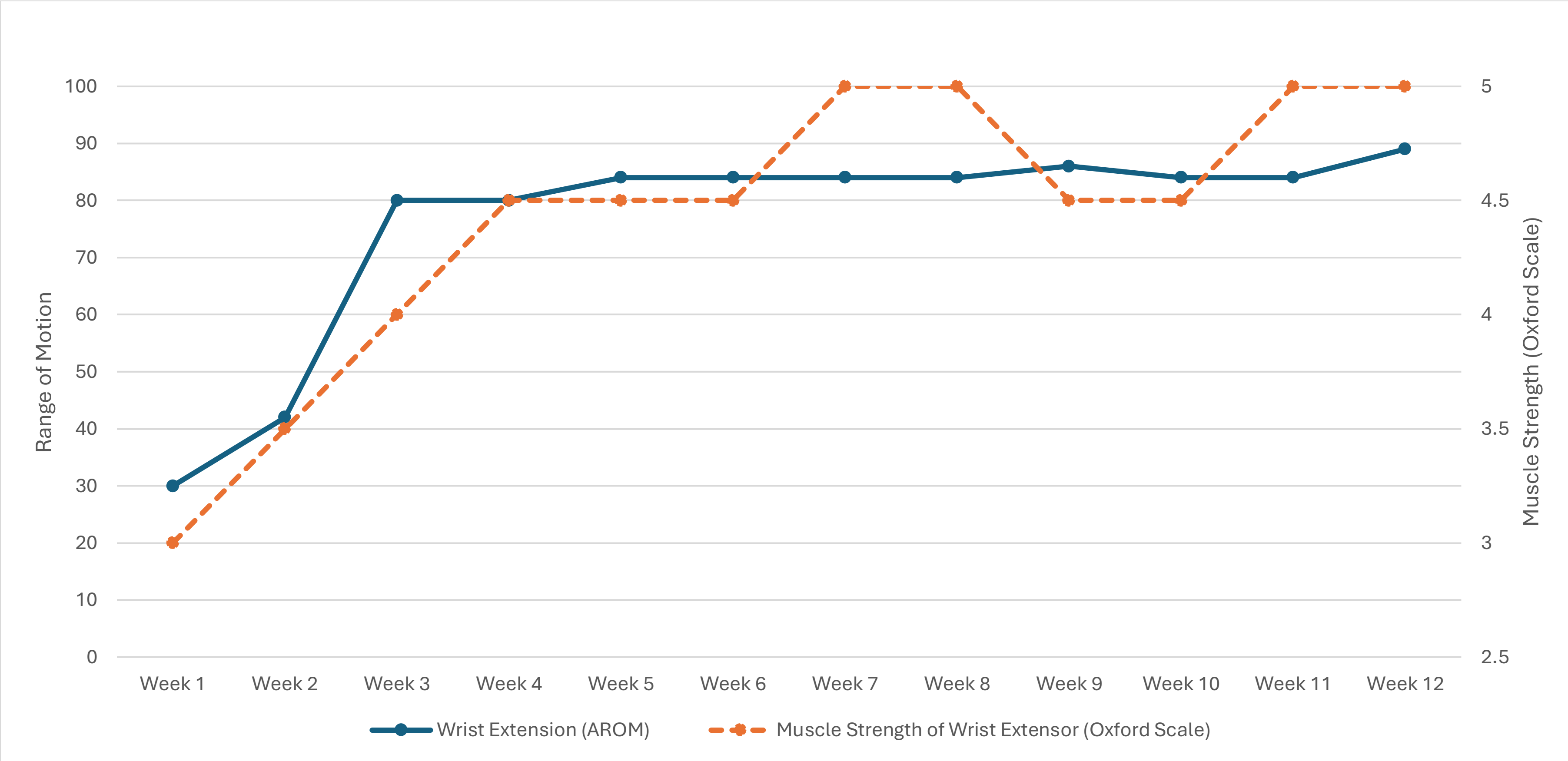

Figure 19 – Wrist Extension (AROM) & Muscle Strength Across 12 Weeks.

4. Discussion

Biomechanical Demands of the Wrist as an Axial Weight-Bearing Joint System

In contemporary dance practice, the wrist complex frequently ceases to function as an open-chain manipulation tool and is instead transformed into a primary axial weight-bearing structure (Russell, 2013). During the terminal phase of an unassisted vertical handstand hold, total bodyweight axial compression forces are absorbed by the radio-carpal joint surface while it is held at a maximal closing angle of extension. An analytical breakdown of this position indicates that the mechanical force distribution shifts from the lower extremity to an upper-limb base of support, where the joint contact area of the radio-scaphoid and radio-lunate interfaces handles substantial localised loading pressure. This distinct loading environment explains why localised, late-stage joint discomfort and premature fatigue were presented by the student as she approached the 10-second mark of her handstand assessment, despite possessing a symmetrical 89° of active extension and 5/5 (Oxford scale) muscle strength. Inverted balance maintenance relies on a complex biomechanical "wrist strategy," requiring rapid, high-frequency contractions of the forearm musculature to continuously shift the centre of pressure over a highly restricted base of support (MacDonald & Heinen, 2025). Exceptional structural shear stress is generated by this intense motor control demand across the consolidating cortical bone of the distal radius and its supporting carpal ligamentous framework, proving that tissue reconditioning must extend beyond simple mobility to achieve athletic tolerance.

Biological and Psychological Synthesis of Graded Exposure and Load Management

The clinical effectiveness of a structured graded exposure framework integrated with load management principles is highlighted in this rehabilitation protocol for navigating the post-fracture remodelling phase (Collis et al., 2022; Vlaeyen et al., 2001). A neurocognitive disconnect is commonly observed in dancers following prolonged cast immobilisation. Although structural readiness may be indicated by the presence of cortical bone callus on radiographic imaging, high levels of functional apprehension and protective muscular guarding are often exhibited by the central nervous system as a mechanism to prevent reinjury (Kaur & Zeppieri, 2026). When attempts are made to override these protective responses using aggressive, time-based rehabilitation schedules, inflammatory pain flare-ups are frequently triggered and kinesiophobia may be exacerbated.

To address this, complex choreographic movements are divided into basic mechanical components, allowing tissue recovery to be guided safely through the principles of cellular mechano-transduction (Khan & Scott, 2009). Rehabilitation is initiated with open-chain, submaximal isometric exercises, followed by a systematic progression to closed-chain sagittal plane weight-shifting on a stable surface. This is further advanced to a modified four-point kneeling position using a declined wedge. Through this modification, loading of more than 80% of axial body weight is permitted in the upper limb while excessive wrist extension is limited. In this way, adequate mechanical stimulation is provided to support collagen fibre alignment and bone remodelling, while excessive stress on the healing joint capsule and radius is avoided.

However, progression is not always linear, as demonstrated by a transient increase in pain experienced during a dynamic pushing movement in a live performance during phase 3. This response highlights the unpredictable, multidirectional shear forces during the later stages of tissue remodelling.

To foster mechanical resilience, diverse loading strategies and multidirectional resistance vectors must be proactively integrated into late-stage rehabilitation. In this case, the conditioning framework was expanded to include multi-planar closed-kinetic-chain tasks, such as asymmetrical hand-walking patterns, reactive upper-extremity plyometric catching drills, perturbed quadrupedal stability holds, and tri-axial perturbations. Such functional elements were systematically incorporated to challenge the remodelling osseous and capsular structures across multiple vectors, thereby replicating the unpredictable, multidirectional shear force demands encountered in choreographic performance. Therefore, continuous monitoring and close coordination with performance staff are required to allow real-time adjustments to training load and movement demands (Gabbett, 2016; Soligard et al., 2016).

Impact of Early Rehabilitation and Range of Motion (ROM) Training

Early mobilisation plays a crucial role in overall tissue healing and functional rehabilitation by actively accelerating tissue remodelling. The bone and soft tissues adapt and remodel dynamically in response to specific external mechanical forces, becoming structurally stronger and more functionally resilient when appropriate physical stress is applied across the healing phases (Bornstein et al., 2021; Khan & Scott, 2009).

From an osseous perspective, the application of early, progressive mechanical loading plays a vital role in bone healing by triggering primary mechano-transduction mechanisms within the callus fracture site (Khan & Scott, 2009). Controlled axial weight-bearing stresses stimulate osteoblast differentiation and deregulate local vascular endothelial growth factors, which are essential to accelerate the conversion of soft cartilaginous calluses into structurally hard, woven bone tissue (Chamberlain et al., 2009). Early yet highly progressive proprioceptive and sensorimotor exercises were found to be particularly beneficial in this case, as functional outcomes and joint position awareness were significantly improved without placing excessive or deleterious shear stress across the healing osseous and capsular tissues.

Furthermore, the maintenance of adequate joint ROM is recognised as a vital component for a safe, structured return-to-play timeline. Pre-season and post-injury research suggest that restricted or lower baseline ROM values significantly elevate the subsequent risk of soft-tissue strains and joint injuries, which directly impacts long-term athletic performance profiles (Bradley & Portas, 2007). Within this case presentation, early goniometric ROM tracking and progressive manual therapy successfully prevented chronic secondary ROM deficits. A safer and more biomechanically effective return-to-dance process was therefore supported through this early intervention framework.

Interdisciplinary Interventions and Methodological Limitations

The outcome of this case was enhanced by the structured collaboration between clinical physical therapy and the Dance Science Team's Fit to Train performance conditioning program. It is shown by an analysis of the joint programming that systemic deconditioning was prevented and her academic progression was supported by the interdisciplinary team through the implementation of a parallel, periodised strength program that prioritised hand-free lower-extremity muscle strengthening and multi-planar core stabilisation. Performing readiness was maintained by the team through this multi-disciplinary bridge, ensuring that her semester curriculum could be completed on schedule without experiencing the severe physical decline common after prolonged rest.

Nonetheless, several methodological limitations must be considered when reviewing these findings. Because clinical manual therapy, therapeutic ultrasound, instrument-assisted cupping, and a high-volume conditioning program were administered simultaneously, the independent statistical efficacy of any single intervention cannot be isolated or determined. Furthermore, as a single-subject case study evaluating an elite 22-year-old female athlete, these specific timelines and tissue recovery rates cannot be generalised to complex, intra-articular, or displaced fractures where rigid surgical fixation is required (Beleckas & Calfee, 2017). Finally, our ability to confirm the permanent structural stability and long-term joint health of the radio-carpal construct under multi-year professional dance workloads is limited by the lack of long-term objective follow-up data beyond her initial 12-week discharge assessment.

5. Conclusion

The management of an acute distal radius fracture in a collegiate contemporary dancer is presented in this case report, with emphasis placed on the clinical efficacy of combining advanced localised physical modalities with a highly coordinated institutional load-management network. Through the implementation of a structured Fit to Train program and a multidisciplinary communication framework, safe and continuous progression was collectively supervised by clinicians, dance science staff, and departmental choreographers throughout the academic semester.

Post-immobilisation capsular restrictions were successfully addressed through early intervention and progressive manual therapy, allowing full range-of-motion symmetry to be achieved by Week 4 in flexion and by Week 11 in extension, without disruption to concurrent academic training requirements. From a mechanobiological perspective, sufficient mechanical stimuli were provided through the immediate initiation of post-cast sports therapy and early graded closed-kinetic-chain progression, facilitating optimal bone and soft-tissue remodelling alignment.

Primary mechano-transduction processes were effectively stimulated through controlled early exposure to closed-chain shear loading, resulting in accelerated alignment of regenerating collagen fibers and prevention of chronic arthrofibrotic joint limitations (Bornstein et al., 2021; Khan & Scott, 2009). As a result, the risk of re-injury during handstand transitions was reduced.

While standalone interventions often fail to address the complex movement, demands required in professional dance, a comprehensive performance-preservation progress is established, enabling a safer and more predictable return-to-dance trajectory. To further validate the clinical utility and therapeutic efficiency of similar dance rehabilitation, future large-scale cohort studies and randomised controlled trials within professional performing arts institutions are strongly recommended.

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VOLUME 2 ISSUE 1

Exercise Highlight 1

Flywheel Hip Extension & Leg Curl: A Useful Training and Monitoring Tool for Hamstring Strain Return-to-Play Process

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1. Introduction

Hamstring strain injuries (HSIs) remain one of the most common and burdensome soft-tissue injuries in sports, particularly in football, sprinting, and field-based activities (Dalton et al., 2015). They frequently cause significant time loss and demonstrate reinjury rates of 20-30% or higher within the first few months after return to play (RTP) (Danielsson et al., 2020; Perna et al., 2025).

During high-speed running, the hamstrings face peak vulnerability in the late swing to early stance (touchdown) phase (Bramah et al., 2024a). The biceps femoris long head undergoes substantial eccentric loading as it decelerates the forward-swinging trunk leaning while the hip flexes and the knee extends (Pietraszewski et al., 2025). This positions the muscle-tendon unit at long lengths under high force demands. If the hamstrings lack adequate strength, extensibility (flexibility), or neuromuscular control to tolerate these forces, microtears or strains develop (Bramah et al., 2024b). This sprint-type mechanism underscores the importance of rehabilitation that specifically targets lengthened-position eccentric control, flexibility, and neuromuscular coordination rather than single-muscle-group strengthening alone.

Current hamstring testing and strengthening protocols have notable limitations in replicating these sport-specific demands. Common methods include isokinetic dynamometry (concentric and eccentric knee flexion), the Nordic hamstring exercise (NHE), isometric testing, and handheld dynamometry (Perna et al., 2026). While these tools effectively quantify torque and asymmetries, many do not fully replicate the open-chain, lengthened hamstring positions experienced during sprint touchdown. Eccentric isokinetic tests and the NHE often emphasise knee-dominant motion (knee flexion), primarily loads at greater angles that may under-target the proximal biceps femoris or hip-extension demands of running. Isometric assessments measure force production at a fixed joint angle with no muscle lengthening or shortening, providing only a static snapshot of strength (James et al., 2023). This fails to capture the dynamic eccentric control required during sprinting, where the hamstrings must actively lengthen under high velocity and load to absorb energy (James et al., 2023). Therefore, mismatch can leave residual deficits even when athletes pass standard clearance criteria.

Flywheel devices generate variable resistance via a rotating disc, enabling maximal concentric efforts followed by controlled supramaximal eccentric overload (Beato, De Keijzer, et al., 2024). Flywheel (inertial) resistance training potentially provides a reliable and valid alternative that better replicates these demands as it allows practitioners to track progress using real-time power output metrics (including concentric peak power, eccentric peak power, and eccentric: concentric ratios) while replicating motion patterns more similar to the high-speed sprint touchdown mechanism (Bishop et al., 2023; De Keijzer et al., 2022; Mak et al., 2025). Recent evidence highlights that practitioners are increasingly adopting these technologies for injury management and performance assessment, though researchers emphasised the need for standardised assessment protocol to maximise clinical utility (Mak et al., 2026). Multiple studies confirm the reliability of flywheel hip extension and leg curl tests. Flywheel Hip Extension and Leg Curl Tests demonstrated moderate to good between-session reliability for these flywheel assessments, along with meaningful associations to isokinetic hamstring strength measures (Nutarelli et al., 2026).

Figure 1– Flywheel leg curl.

Figure 2 – Flywheel hip extension.

2. Practical Implications

Practitioners can objectively monitor strength, control, and tissue tolerance while simultaneously enhancing flexibility through full-range controlled movements (Mak et al., 2025). Flywheel hip extension (hip-dominant, targeting proximal hamstrings) and flywheel leg curl (knee-dominant) exercises are particularly applicable (Figures 1 & 2). Hip extension variants load the biceps femoris long head at lengths similar to late swing, while leg curls build hamstring capacity. Studies support this training effectively bridging gym-based rehabilitation to on-field sprinting (De Keijzer et al., 2022, 2024; Perna et al., 2024). Evidence strongly supports their use in later RTP stages. Scoping reviews and clinical guidelines for professional football RTP criteria emphasise individualised, mechanism-specific protocols that include strength at long muscle lengths, eccentric control, and gradual exposure to high-speed running (Perna et al., 2024, 2026). Additional studies highlight flywheel training's role in improving overall lower-limb power, asymmetry reduction, and adaptations critical for injury resilience (Beato et al., 2021; Beato, De Keijzer, et al., 2024).

Practitioners should incorporate flywheel hip extension and leg curl exercises mainly in the intermediate-to-late stages of RTP, typically after pain-free jogging, basic strength symmetry, and initial eccentric tolerance are achieved (Perna et al., 2024). Begin with lower inertia discs for technique mastery and progress to higher inertia for overload. A typical prescription includes 3–5 sets of 6–10 repetitions (or until power declines by 20-30%), 2–3 sessions per week, prioritising explosive concentric actions and controlled eccentric braking. Unilateral execution is essential to correct asymmetries (Beato, de Keijzer, et al., 2024; Bettariga et al., 2022). Monitoring should integrate flywheel power output metrics, adjunct isokinetic or isometric testing, pain scales, and functional tests such as the Askling H-test or single-leg hop variations. Full RTP clearance should require pain-free full range of motion, near-maximal sprint tolerance, and successful match simulation (Perna et al., 2026), with good psychological readiness and confidence.

3. Conclusion

Flywheel hip extension and leg curl exercises offer a valuable, mechanism-specific tool for hamstring strain RTP protocols. By replicating the lengthened eccentric demands of sprint touchdown while delivering reliable, trackable power output metrics for strength, control, and progress, they address key shortcomings of traditional testing and training. When thoughtfully integrated into later RTP stages as part of a tailored program, they enhance resilience, support concurrent development of strength, control, and flexibility, and may help reduce reinjury risk, ultimately facilitating a safer and more effective return to high-level performance. However, there is no single 'silver bullet' in the RTP process. All factors must be carefully considered and properly addressed throughout the process to minimise athletes' risk of reinjury and optimise their performance.

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STJ
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Exercise Highlight 2

Rethinking the Biomechanical Importance of Transverse Plane: Balancing Hip Internal Rotation Mobility with Eccentric External Rotator Strength for Lower-Limb Injury Prevention

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1. Introduction

Lower extremity overuse injuries, specifically patellofemoral pain syndrome (PFPS) and iliotibial band (ITB) syndrome, remain notoriously persistent challenges in sports therapy. Over the past decade, evidence-based management has heavily prioritised proximal hip strengthening, primarily focusing on the gluteus maximus and the posterior fibres of the gluteus medius (Rinaldi et al., 2022). The theoretical mechanism centers on maximising hip external rotation and abduction to counteract dynamic knee valgus—a primary biomechanical fault implicated in lateral patellar tracking and ITB compression. High-quality systematic reviews consistently demonstrate that targeted strengthening of the hip abductors and external rotators significantly reduces pain and improves functional outcomes (Barton et al., 2015; Rabelo et al., 2018). Consequently, clam-shells, banded lateral walks, and targeted gluteal external rotation activations have become the undisputed cornerstone of lower-limb rehabilitation (Willy et al., 2019).

However, an exclusive focus on absolute concentric external rotation capacity creates an incomplete clinical paradigm. Practitioners may overlook a critical prerequisite: hip internal rotation (IR) mobility. Furthermore, a common clinical misconception involves misclassifying complex standing drills; exercises like the single-leg Romanian Deadlift (RDL) or lateral step-down are frequently misconstrued as simple strengthening drills focusing on the concentric phase of agonists, whereas they also simultaneously challenge the eccentric capacity of the external rotators to decelerate internal rotation across a functional range of motion. Restoring true lower-limb resilience requires rehabilitation professionals to shift away from isolated concentric training, moving toward a balanced framework combining joint-specific hip IR mobility with robust eccentric external rotation (ER) control.

Functional Anatomy in Walking Gait

To design effective preventative protocols, practitioners must evaluate the complex, multi-planar mechanics of the hip musculature during standard walking gait. The stance phase of walking generates distinct kinetic forces that require precise neuromuscular deceleration. Immediately following heel strike, during the loading response and early midstance, the weight-bearing foot grounds itself, causing the pelvis to naturally rotate anteriorly and internally over the fixed femur (Bramah et al., 2018). This motion creates a relative hip internal rotation and adduction torque. In healthy individuals, fine-wire electromyography (EMG) profiles confirm that this transverse plane motion is guided and actively stabilised by the synchronised activation of the anterior fibres of the gluteus medius, the tensor fasciae latae (TFL), and the adductor complex (including the adductor longus and magnus) (Semciw et al., 2016). Crucially, this rapid internal pelvic and femoral rotation must be decelerated to prevent an uncontrolled medial collapse into dynamic knee valgus. This responsibility falls directly upon the primary external rotators—the gluteus maximus and the posterior fibres of the gluteus medius—which must fire eccentrically to absorb impact and control the rate of internal rotation (Mucha et al., 2017). If an athlete possesses structural hip IR mobility restrictions, the femur cannot centrate properly within the acetabulum during gait, forcing compensatory tibial external rotation or mid-foot pronation down the kinetic chain. Conversely, if an athlete has adequate mobility but lacks the eccentric strength of the external rotators to control this internal range, the soft tissues of the knee bear excessive mechanical stress (Willy et al., 2019). Thus, injury prevention depends on a joint's capacity to access internal rotation range, combined with the neuromuscular strength to eccentrically decelerate it.

2. Clinical Application: Three Foundational Hip Internal Rotation Exercises

Addressing hip internal rotation deficits requires a structured transition from gravity-eliminated isolation to dynamic, weight-bearing integration. The following three exercises progressively challenge the hip joint through this specific biomechanical framework.

Side- Lying 90-90 Hip Internal Rotation

This foundational isolation exercise positions the patient in a side-lying posture with hips and knees flexed to exactly 90 degrees (Figure 1). A foam roller or firm block is placed between the knees to maintain neutral abduction and isolate the transverse plane. The patient actively lifts the top foot toward the ceiling, driving the femur into internal rotation against gravity or an applied resistance band. By flexing the hip to 90 degrees, the line of pull optimises the mechanical advantage of the anterior gluteus medius and TFL while temporarily inhibiting the posterior gluteal fibres (Macadam et al., 2015). This exercise is essential for establishing baseline neuromuscular awareness and mobility in the hip IR before progressing to more complex, standing movements.

Figure 1 – Isolated hip internal rotation exercise in side lying position position

Single-Leg Romanian Deadlift (RDL) with Hip Rotation

The single-leg RDL represents a vital closed-kinetic chain progression (Figure 2a and b). The patient hinges at the hip while maintaining a neutral spine on a single stance leg. At the terminal range of the hinge, the patient actively rotates the non-stance side of the pelvis downward toward the floor, driving the stance hip into relative internal rotation, before rotating back to square. Although the pelvis moves into internal rotation, this drill serves as an advanced challenge for the eccentric strength of the hip ER. The gluteus maximus and posterior gluteus medius must lengthen under tension to control and decelerate the pelvic rotation over the stationary femur (De Oliveira Silva et al., 2018; Mo et al., 2023). This directly strengthens the muscular deceleration mechanism required during the loading phase of gait.

Figures 2a & b – Single-leg Romanian deadlift with hip internal rotation integration.

Lateral Step- Down with Contralateral Load

The patient stands on an elevated block and executes a slow, controlled step-down while holding a dumbbell in the contralateral hand. The addition of a contralateral load creates an increased rotational torque and lateral tilt, pulling the pelvis into relative external rotation. To maintain a square pelvis and proper knee alignment, the stance leg's internal rotators must stabilise the pelvis while the external rotators work eccentrically to manage the descent and prevent dynamic knee valgus (Hotta et al., 2020). This exercise trains multi-planar control under progressive gravitational loading, closely replicating the deceleration demands of everyday movements like walking down stairs.

Figure 3 – Lateral step-down exercise.

3. Practical Implementation and Clinical Integration

Integrating hip internal rotation exercises into standard rehabilitation protocols requires clinical precision and intent. For patients suffering from PFPS or ITB syndrome, restoring hip IR mobility and ER eccentric strength directly unloads the lateral joint compartment. When the hip internal and external rotators can effectively control pelvic rotation during the loading response of running or the eccentric phase of stair descent, the femur remains dynamically centred. This dynamic centration prevents the excessive, uncontrolled internal femoral collapse that pinches the ITB against the lateral femoral epicondyle and drags the patella laterally against the trochlear groove (Mucha et al., 2017).

Exercise prescription should closely mirror the patient's irritability levels and tissue tolerance. Clinicians should initiate rehabilitation with the side-lying 90-90 internal rotation (3 sets of 12-15 repetitions) to build local tissue capacity, increase blood flow, and alleviate acute symptoms without overloading the knee joint. As motor control in simple weight-bearing tasks improves and pain subsides, practitioners may progressively and aggressively integrate the single-leg RDL with rotation and the contralaterally loaded lateral step-down (3 sets of 8-10 repetitions) to replicate the demands of functional, daily tasks, especially at the later stage. This approach ensures adequate hip IR mobility while building eccentric ER torque, which helps eliminate structural compensations and normalises patellofemoral tracking during daily functional activities (Crossley et al., 2016). Ultimately, by rethinking the importance of hip IR and eccentric strength of ER, Sports Therapists can design more comprehensive, effective solutions for chronic lower extremity pathologies.

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Exercise Highlight 3

The Clinical Implications of Eccentric Exercises for Rehabilitating and Preventing Shoulder Injuries in Overhead Athletes

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The shoulder joint relies on a complex interaction between muscles, ligaments, tendons and connective tissue to remain stable. The rotator cuff complex consists of the supraspinatus, infraspinatus, teres minor and subscapularis muscles, which work together to maintain stability of the glenohumeral joint during both concentric and eccentric contractions. The posterior rotator cuff, particularly the infraspinatus and teres minor, plays a key role during overhead movements by working eccentrically to decelerate the arm in the follow-through phase of throwing and similar actions (Valier et al., 2014). This role is especially important at the terminal position of shoulder internal rotation and adduction, where the posterior rotator cuff is placed under high mechanical demand. Trasolini et al. (2022) highlighted that in this position, the infraspinatus and teres minor are required to generate significant eccentric force to control joint motion and protect the glenohumeral structures. As a result, insufficient strength or load tolerance in these muscles may increase injury risk in overhead athletes, reinforcing the importance of targeted eccentric training within rehabilitation programmes (Camargo et al., 2014).

Given the anatomical complexity and high injury prevalence associated with the shoulder in these sports, the role of eccentric training in enhancing recovery and performance has become an important focus in sports medicine (Camargo et al., 2014). Chronic overuse, particularly when it starts early in sports careers, has been associated with long-term shoulder problems. This emphasises the importance of understanding shoulder anatomy to develop effective rehabilitation strategies (Cools et al., 2015).

In this regard, eccentric exercises have become essential in the rehabilitation and prevention of shoulder injuries, especially for athletes participating in overhead sports like cricket, handball, swimming and tennis (Valier et al., 2014). These sports impose substantial loads on the shoulder through repeated high-velocity movements, creating an increased risk for microtrauma and overuse injuries (Cools et al., 2015). Eccentric training focuses on controlled muscle lengthening while under tension. Research indicates that it can improve functional capacity, joint stability and reduce pain more effectively than traditional concentric exercise methods (Ortega-Castillo & Medina-Porqueres, 2015). Eccentric exercises play a critical role in managing shoulder injuries among overhead athletes by enhancing tendon remodelling and rotator cuff strength under high deceleration loads (Camargo et al., 2014). Programs such as the Throwers Ten include eccentric components to tackle common problems like impingement and scapular dyskinesis in sports. These interventions help enhance stability and performance, while also lowering the risk of injuries (Patel & Vaishnav, 2025).

Eccentric exercises emphasise the eccentric phase of muscle contractions, where the muscles lengthen under tension. This approach contrasts with concentric exercises, which focus on shortening the muscles during movement. Eccentric training has been shown to offer various benefits, such as enhanced strength and neuromuscular control, especially for the muscles in the back of the shoulder (Hody et al., 2019). Studies show that eccentric exercises work better than concentric exercises for improving shoulder function and lowering pain levels in people with shoulder injuries.

Hedt et al. (2020) reported that side-lying eccentric horizontal abduction produces high levels of activation in the infraspinatus and teres minor, while limiting the contribution of other shoulder muscles. This makes it a useful exercise for selectively targeting the posterior rotator cuff during rehabilitation. The importance of this activation is supported by Ha et al. (2013), who highlighted the key role of the infraspinatus in providing dynamic shoulder stability and generating external rotation force. During overhead throwing actions, the infraspinatus also contributes an approximation force that helps resist distraction at the glenohumeral joint, further emphasising the value of eccentric training for shoulder control and injury prevention.

Figure 1, 2 & 3 – The demonstration of side-lying eccentric horizontal abduction.

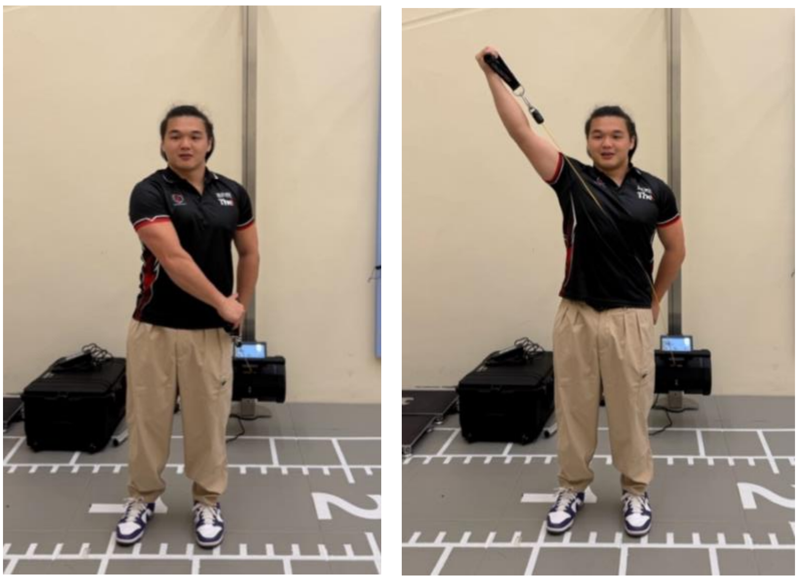

Figure 4 & 5 – D2 Shoulder extension with 1080 Cable.

Figure 6 – Reverse catch deceleration training exercise with weight ball.

Eccentric exercises have been shown to provide significant benefits in the rehabilitation of shoulder injuries, particularly for athletes involved in overhead sports (Cools et al., 2020). These exercises focus on the lengthening of muscles while they develop tension, which has been found to improve shoulder function and reduce pain intensity more effectively than concentric exercises. Studies report that eccentric exercise training enhances shoulder mobility and rotator cuff strength, contributing to overall improvements in shoulder function (Macías-Hernández et al., 2020). Maenhour et al. (2012) suggested that heavy-load eccentric training resulted in improvement of isometric strength. In the loaded eccentric progression (Figure 4-5), the 1080 Cable allows computer-controlled concentric and eccentric resistance, facilitating precise load progression in sport-specific positions. In addition, Kovacs et al. (2008) described the reverse catch drill (Figure 6), which emphasises deceleration of the ball as the arm continues forward after the catch, thereby targeting the eccentric function of the rotator cuff and scapular stabilisers during the deceleration phase of overhead motions.

Application in Rehabilitation and Performance Enhancement

Eccentric exercises are a vital component of rehabilitation programs for conditions such as rotator cuff tendinopathy, posterior shoulder capsule tightness and glenohumeral internal rotation deficit (GIRD) (Camargo, 2014). Rehabilitation typically begins with isometric loading, followed by concentric and then eccentric phases as recovery progresses. This graded approach allows tissues to adapt gradually to increasing mechanical demands.

Specific eccentric exercises, such as external rotation using resistance bands, slow eccentric lowering during shoulder scaption and eccentric push-up plus variations, help strengthen both the rotator cuff and scapular stabilisers (Mike et al., 2016). These exercises not only restore strength but also refine proprioception and coordination. When integrated into kinetic chain training, eccentric exercises enhance trunk and scapular control, which is essential for powerful and efficient overhead movement.

For performance enhancement, eccentric training improves force absorption, deceleration capacity and overall control during rapid transitions. Athletes who incorporate eccentric components have demonstrated superior throw velocity, shoulder endurance and resilience to repetitive stress (Zhang et al., 2024).

Conclusion

Eccentric exercises represent an evidence-supported approach for the rehabilitation and prevention of shoulder injuries in overhead athletes. By improving muscular strength, tendon structure and neuromuscular control, both recovery and performance could be improved. Structured, sport-specific protocols that emphasise movement quality, progressive loading and consistency can significantly reduce the incidence of shoulder injuries and potentially extend sports career. Continued research should focus on optimising eccentric parameters, understanding tendon adaptation timelines and evaluating long-term effects on shoulder performance across different sports.

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Exercise Highlight 4

Differential Learning in Neuromuscular Training: Implications for Motor Programme Adaptation and Sport-Specific Transfer

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1. Introduction

Neuromuscular training (NMT) has been widely adopted by strength and conditioning coaches and therapists for both performance enhancement, post-injury sports rehabilitation, and sports injury prevention (Chen et al., 2025; Stergiou et al., 2025; Zhou et al., 2026). Common NMT modalities include strength training, plyometric exercises, stability training, and speed, agility, and quickness (SAQ) drills. These methods aim to improve intra- and inter-muscular coordination, sensorimotor integration, and the overall efficiency of the kinetic chain (Almansoof et al., 2023; Yang et al., 2026; Zhang et al., 2026).

Traditionally, athletes and patients are instructed to perform selected NMT exercises with “optimal” posture, standardized movement speed, and movements confined to predetermined planes and joint angles. For example, during an overhead press, practitioners often instruct that the elbows should be positioned at approximately 90° in the bottom position, and the load should be lifted vertically overhead at a controlled tempo (e.g., 2 seconds concentric and 2 seconds eccentric). While such prescriptive approaches may enhance technical consistency, it remains questionable whether strictly predefined “ideal” movement patterns maximize transferability to dynamic, unpredictable sport environments (Arede et al., 2025). Therefore, traditional rehabilitation strategies focusing on repetitive practice and error corrections in relatively stable, pre-determined and well-controlled settings to restore physical capacity, movement biomechanics and motor controls may not provide desirable environments to athletes for returning to sports and game.

If movement adaptability and the ability to respond effectively to game-specific demands are primary training goals, the appropriateness of rigid, repetitive exercise prescriptions warrants reconsideration. In real-world sporting contexts, movements are rarely performed under identical conditions. Thus, training models that emphasize variability may better align with the ecological dynamics of sport (Renshaw et al., 2022).

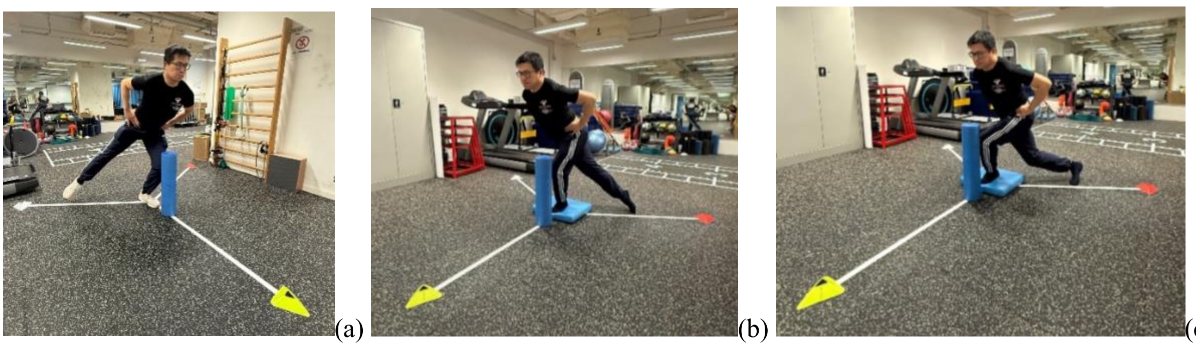
2. Differential Learning in Neuromuscular Training

In this context, the concept of differential learning (DL) has recently gained attention within sports rehabilitation and strength and conditioning practice. The central premise of DL is the intentional incorporation of movement variability to enhance motor learning and adaptability (Arede et al., 2025; Ghanati et al., 2022; Gholami et al., 2023). In open-skill sports such as tennis, no two strokes are identical. Variations in ball trajectory, speed, spin, and landing position necessitate continuous movement adaptations. Accordingly, some degree of inter-trial variability is inherent and functionally necessary. Repeating neuromuscular exercises with identical speed, trajectory, and joint angles across repetitions may therefore limit opportunities to refine motor programs and develop adaptable movement solutions.

From a motor learning perspective, increased movement variability facilitates self-organization of the neuromuscular system. Through exposure to diverse movement scenarios, athletes accumulate experience across a broad range of task constraints. This may enhance their capacity to autonomously select optimal motor solutions in response to novel or unpredictable challenges (Tassignon et al., 2021). DL can be implemented by systematically manipulating movement speed, joint angles, body positions, task demands, or environmental contexts within and between sets. For instance, the traditional split squat or single-leg squat is commonly prescribed to improve lower limb strength and dynamic knee and ankle stability. Practitioners often provide internal cues such as "squat to 60–90°," "activate the gluteal muscles to control knee alignment," or "maintain a 2-second up and down tempo." In contrast, incorporating external targets and DL principles may promote greater self-organization and movement optimization.

3. Applications

Single-leg squat and Y-balance variations



(a) (b) (c)

Figure 1 – (a) Single-leg squat integrated with a Y-balance task performed according to color-cone commands (left); (b) same movement and task performed on an unstable surface; and (c) diagonal split-squat variation incorporating Y-balance elements on an unstable surface.

Figures 1 a - c demonstrate the variations of single-leg or split-squat exercises with directional reach (color-coded targets) and surface stability (stable floor vs. balance pad). Other modifications in sequences (based on instruction), movement speed (fast vs. slow), depth (standard vs. deep), etc. can be made for further challenges in cognition, movement patterns, and more. To enhance self-correction and awareness of knee alignment, a foam roller can be placed anteriorly to the patella to serve as an external cue. Practitioners can also prescribe different squat or Y-balance variations in each repetition or set, thereby applying DL principles.

Deceleration and Visual-Motor Coupling

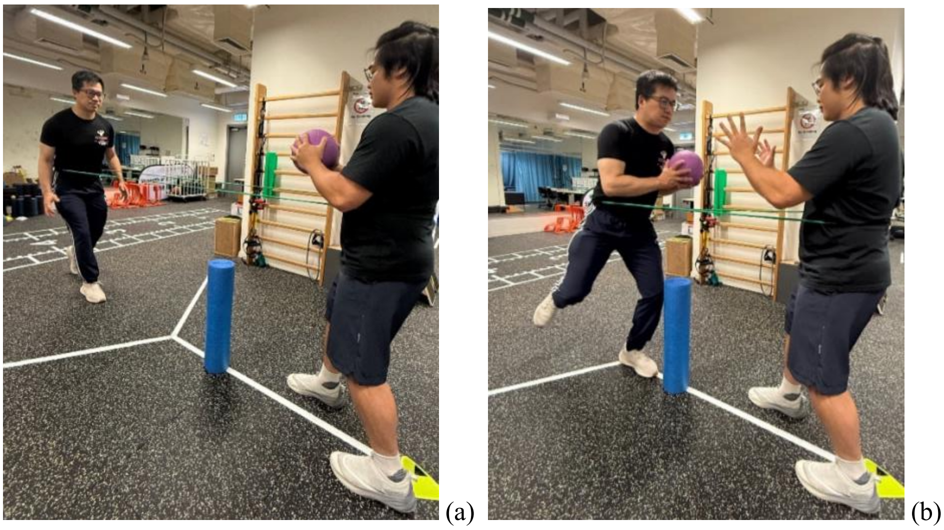

(a) (b)

Figure 2a & b – Single-leg squat with deceleration and visual-motor coupling tasks

Figures 2a and 2b demonstrate the use of elastic band (or power cord) to introduce deceleration demands during a single-leg squat hold, thereby increasing braking and knee control requirements. Incorporating ball-catching and throwing tasks at varying angles and positions adds a visual–motor coupling component, enhancing sensorimotor integration and hand–eye coordination. These dual-task (motor–motor) conditions increase neurocognitive demand while maintaining the primary lower limb control objective. Furthermore, forward acceleration–deceleration drills may better emphasize dynamic control compared with relatively static Y-balance tasks.

Agility and Footwork Training

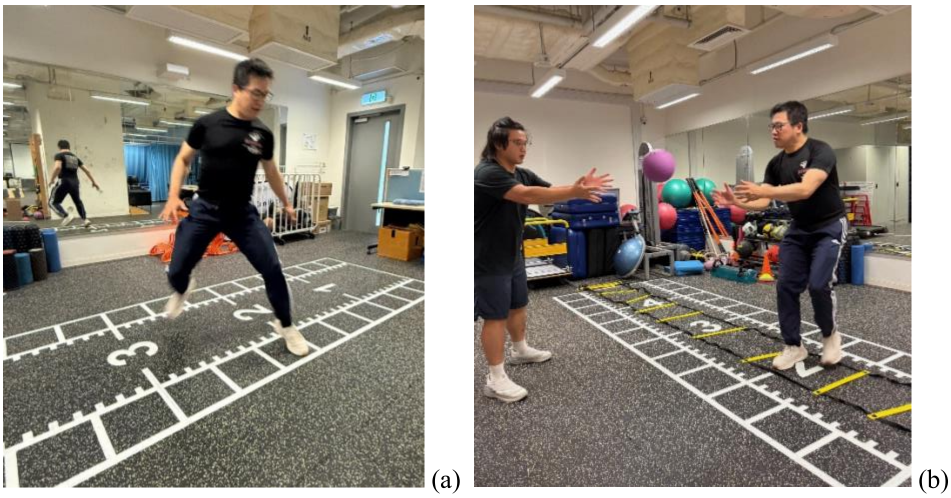

(a) (b)

Figure 3 – (a) Traditional agility ladder drills performed with fixed spacing and predetermined patterns; and (b) Agility ladder exercises modified according to DL principles.

Athletes undergoing sports rehabilitation are frequently prescribed conventional agility ladder drills using standardised spacing and repetitive patterns. However, in sports such as soccer, tennis, basketball, and rugby, footwork patterns are highly variable and context-dependent. Repeatedly performing ladder drills with fixed dimensions and routines may constrain degrees of freedom and limit training transfer (Figure 3a).

In contrast, modifying ladder size, spacing, orientation, or configuration can introduce additional variability and adaptive demands. Incorporating partner interaction, such as ball catching, throwing, or dribbling during footwork drills, transforms the task from a closed-skill into a more open-skill condition, increasing visual-motor coupling and contextual interference.

4. Conclusion

Predefined exercise formats with low contextual interference may serve as an appropriate starting point for developing foundational movement competencies, including basic body control, stability, and coordination. However, exclusive reliance on rigid, repetitive movement prescriptions may limit adaptability and sport-specific transfer.

The incorporation of differential learning principles—through structured movement variability and contextual manipulation—may enrich motor engrams, enhance self-organization, and optimize neuromuscular and neurocognitive adaptations. Such approaches may ultimately improve the transfer of rehabilitation and training outcomes to complex, sport-specific environments.

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The Gen-AI (POE) was used purely for English editing and structural refinement for this article, while all the intellectual contribution is from the author and the AI was only used for mechanical language enhancement.

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Exercise Highlight 5

Incorporating the Co-activation of Serratus Anterior in Overhead Tasks using the Reactive Neuromuscular Training Approach

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1. Introduction

Shoulder injuries, including rotator cuff tendinopathy or muscle strain, are highly prevalent among overhead athletes exposed to repetitive, high-velocity throwing and serving activities (Leong et al., 2025). Scapular dyskinesis has been consistently identified as a predisposing risk factor contributing to altered shoulder biomechanics and increased injury risk (Hickey et al., 2018). Common shoulder-related kinematic impairments or movement dysfunctions include delayed or insufficient scapular upward rotation, excessive anterior tilt, increased internal rotation, the presence of medial border prominence (a.k.a. scapular winging), and the abrupt descent during the downward rotation phase (i.e., scapular dumping) (Lawrence et al., 2019; Yan et al., 2025).

Given that all rotator cuff muscles originate from the scapula, optimal scapular positioning and dynamic control are vital for efficient glenohumeral stabilisation. Impaired scapular stabilisation compromises neuromuscular efficiency, alters length-tension relationships, and reduces force transmission and output capability of the rotator cuff muscles as the primary dynamic stabilisers of our glenohumeral joint (Türkmen et al., 2026). Consequently, sports rehabilitation or injury preventive strategies targeting scapular motor control are keys to both performance optimisation and injury management in overhead athletes.

The serratus anterior plays a pivotal role in scapular stability (Neumann & Camargo, 2019). Biomechanically, it functions as the primary agonist for scapular protraction and a major contributor to upward rotation. Due to its anatomical attachment along the anterior surface of the medial scapular border and inferior angle, it also facilitates posterior tilt (thereby counteracting excessive anterior tilt) and external rotation (reducing medial border prominence). Appropriate activation of the serratus anterior is essential for maintaining optimal scapulothoracic force coupling, particularly in synergy with the upper and lower trapezius, thereby promoting efficient upward rotation and preserving glenohumeral joint centration during overhead motion (Briel et al., 2022; Paine & Voight, 2013).

Although high electromyographic (EMG) amplitudes reported in the literature suggest that certain exercises effectively activate and potentially strengthen the serratus anterior (Edwards et al., 2017), isolated strengthening alone may be insufficient. Scapular stabilisers must demonstrate precise activation timing, coordinated sequencing, and minimal compensatory substitution or pattern to preserve shoulder complex integrity (Francalanci et al., 2026). Therefore, rehabilitation should extend beyond force generation to emphasise neuromuscular control, intermuscular coordination, and task-specific integration. In this context, the serratus anterior should be retrained primarily in its stabilising and synergistic role within functional movement patterns.

2. Clinical Application and Exercise Progression

Stage 1 – Co-activation with Reactive Neuromuscular Training using Elastic Tubing

Figures 1a & b – Shoulder wall slide (eccentric with downward rotation in clockwise direction from 1a to 1b) with banded reactive neuromuscular training

Figure 1 illustrates the application of an elastic tube positioned across the anterior aspect of the scapula. The anteriorly directed tension provides augmented proprioceptive input and facilitates reactive activation of the serratus anterior during both upward rotation (concentric phase in the anti-clockwise direction) and downward rotation (eccentric control in the clockwise direction). Reactive neuromuscular training (RNT) leverages externally applied resistance or tension to enhance sensorimotor integration and refine motor programming. When integrated into functional tasks (e.g. overhead arm elevation) this approach may promote improved scapular awareness and facilitate appropriate activation patterns during dynamic movement. This stage aims to build the foundation, restore activation capacity, and improve neuromuscular responsiveness.

Stage 2 – Integrated Overhead Loading

Figures 2a & b – Shoulder dumbbell overhead press with banded reactive neuromuscular training and scapular hug incorporation

Figure 2 demonstrates progression through the addition of a second elastic band positioned across the upper thoracic and scapular region. While conceptually similar to the traditional scapular hug exercise, this variation incorporates and resembles active overhead motion. The resistance challenges shoulder flexion or abduction while simultaneously loading scapular upward rotation (concentric serratus anterior activity) and requiring controlled downward rotation (eccentric serratus anterior contribution). Transitioning to overhead pressing with free weights (dumbbell or kettlebell) introduces multiplanar freedom and increases neuromuscular demand compared to wall-supported drills. The use of free weights necessitates greater dynamic stability, sensorimotor control, and coordinated scapulothoracic–glenohumeral interaction. Further progression may include unilateral or asymmetrical loading strategies to increase anti-rotational (or anti-lateral flexion) demands and core stabilisation requirements. Such modifications promote integration across the kinetic chain, reinforcing proximal stability during distal upper extremity function.

Stage 3 – Plyometric and Perturbation-Based Progression

Figure 3, it shows the advanced progression incorporates a 1–4 kg medicine ball for overhead plyometric tasks. Rapid, repeated, short-arc single-arm overhead throws with rebound and catch introduce perturbation forces and anti-rotational challenges. This phase more closely replicates the dynamic demands of overhead sport participation. The concurrent use of elastic resistance as an RNT strategy during plyometric throwing reinforces serratus anterior co-activation under high-velocity conditions. The neuromuscular system is thereby required to coordinate both local stabilisers and global musculature within a dynamically unstable environment.

Figures 3 – Medicine ball overhead quick bounce and catch with banded reactive neuromuscular training and scapular hug incorporation.

Enhanced thoracic and rib cage stability, facilitated by improved scapulothoracic control, provides a stable proximal base for force transfer during overhead tasks. To consolidate motor learning and improve transferability, dual-task paradigms incorporating cognitive-motor or motor-motor challenges may be introduced. For example, responding to visual reaction-light stimuli with the contralateral limb during throwing tasks may enhance adaptability and variability of motor output, reflecting the complex demands of sport.

3. Conclusion

Traditional resistance training and isolated muscle strengthening remain valuable for developing intramuscular coordination and foundational strength. However, optimising scapular control in overhead athletes requires a progression toward reactive, task-specific, and integrative neuromuscular training. The incorporation of elastic resistance through reactive neuromuscular strategies may enhance intermuscular coordination, improve force coupling within the scapulothoracic complex, and promote efficient glenohumeral joint centration during overhead function. Rehabilitation programmes should therefore aim not only to increase muscular strength but also to restore adaptive, context-specific motor control that reflects the dynamic demands of sport.

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The Gen-AI (POE) was used purely for English editing and structural refinement for this article, while all the intellectual contribution is from the author, and the AI was only used for mechanical language enhancement.

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STJ JUNE 2026 VOLUME 2 ISSUE 1

Student Research 1 – Abstract

Comparing the Effects of Light and Deep Stroke Massage on Quadriceps Muscle Performance in Collegiate Students

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Background

It is common to believe that massage can offer the ability to improve the muscles strength, joint range of motion and muscles stiffness for the sport performance. However, the effect of massage intensity to muscles stiffness, strength and range of motion is still currently unknown. The current study aims to examine how massage intensity affects the massage intensity to muscles stiffness, strength and range of motion on quadricep muscles.

Methodology

The study examined the differential effects of light stroke massage (3–4 VAS), deep stroke massage (7–8 VAS), and active resting control on quadriceps-related range of motion, muscle strength and stiffness in 15 healthy university students. Participants completed 3 sessions (6 minutes and 30 seconds per condition) separated by at least 48 and up to 72 hours. (a) ROM of knee flexion and extension, and hip flexion and extension; (b) maximal strength of hip flexion and knee extension; and (c) muscle stiffness of the rectus femoris, vastus lateralis, and vastus medialis were assessed pre and post intervention. Two-way repeated measures ANOVA for all variables and the use of ICC (2,1) for reliability were used for data analysis.

Results

The significant treatment mix time interaction was only found in the knee flexion ROM out of all variables, and post-hoc analyses with Bonferroni correction showed that light stroke massage produced a statistically significant improvement, while deep massage and control conditions showed no changes. Strength and stiffness showed no statistically significant differences across all conditions.

Conclusion

The massage intensity differentially influences knee flexion ROM, with light pressure being more effective than deeper pressure massage or no intervention in healthy university students. Proving a short 6.5-minute light stroke massage protocol can offer a simple but efficient strategy to enhance knee mobility without using equipment or causing fatigue.

Student Research 1 – Poster/Infographic

Comparing the effects of light and deep stroke massage on quadriceps muscle performance in collegiate students

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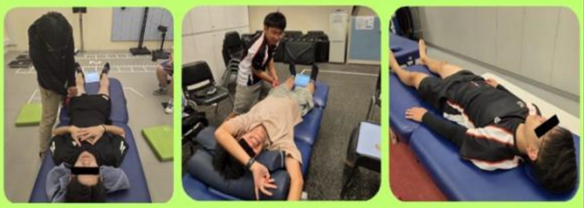
1. PURPOSE and RQs

How does massage intensity →

1. Knee ROM
2. Quad. strength
3. Quad. Muscle stiffness



Light (3-4 VAS) Deep (7-8 VAS) Contorl (rest)

2. METHODS

- 15 healthy university students
- Protocol:
  3 sessions separated by 48–72 hours; 6.5 minutes massage per condition on both legs
- Measurements:
  - ➢ROM: Goniometry
  - ➢Strength: Dynamometry
  - ➢Stiffness: Myoton-PRO
  - ➢Massage force verification: Load pad

- Statistics:
  Two-way repeated measures ANOVA (parametric) + Friedman test (non-parametric)

3. RESULTS

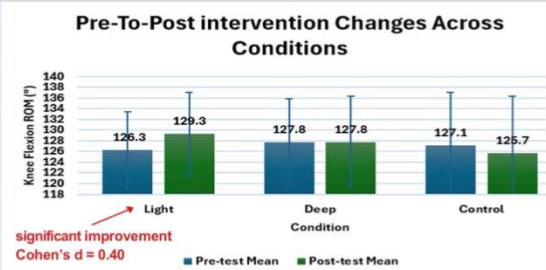


Figure 1 - Knee Flexion ROM – Pre- to Post-Intervention Changes

Table 1	P value (Two-Way Repeated ANOVA)	P value (Friedman test)	Effect size (η_p^2)
ROM: Hip Flexion	0.346	/	0.73
ROM: Hip Extension	0.646	0.191	0.031
ROM: Knee Flexion	0.016*	/	0.255
ROM: Knee Extension	0.703	/	0.016
Strength: Hip Flexion	0.542	0.017*	0.43
Strength: Knee extension	0.275	0.041*	0.088
Stiffness: Rectus Femoris	0.226	/	0.101
Stiffness: Vastus Medius	0.226	/	0.101
Stiffness: Vastus lateralis	0.949	0.435	0.001

Applied post-hoc test

Table 1 – Two-Way Repeated ANOVA and Friedman test

4. DISCUSSION

ROM

- Similar to previous literature → light massage better.
- No acute effect on strength / stiffness

PRACTICAL APPLICATION

- Light stroke massage (3–4 VAS) before training for acute knee ROM ✓
- Deep stroke painful massage for knee ROM or strength. ✗

5. LIMITATIONS

- Small sample size (N = 15 healthy university students) limits generalizability.
- Participants had low baseline muscle stiffness and high functional ability, creating possible ceiling/floor effects.
- Only immediate post-intervention effects were assessed, long-term effects remain unknown

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Student Research 2 – Abstract

Eccentric Force Profiling and Bilateral Asymmetry in Elite Professional Male Cricketers: A Cross-sectional Pilot Study

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Introduction

Fast bowling in cricket imposes high eccentric demands on the shoulder, particularly during the follow-through phase, where the posterior rotator cuff muscles rapidly decelerate the bowling arm. According to the "Brake Hypothesis," repeated exposure to this deceleration should result in superior eccentric external rotation (ER) strength in bowlers. However, normative data on eccentric shoulder strength in elite cricketers remain limited. This study aimed to establish a cross-sectional profile of eccentric rotational strength, bilateral asymmetry, and positional differences among elite professional male cricketers.

Methods

Nine elite male cricketers (4 fast bowlers, 5 batsmen) from the Hong Kong national team participated. Assessments included peak lower-limb deceleration force (1080 Sprint), peak arm angular velocity (Noraxon IMU), and isokinetic/concentric-eccentric shoulder external/internal rotation strength (1080 Cable). Independent t-tests, Cohen's d effect sizes, and Spearman's rank-order correlations were conducted using SPSS v28.

Results

Contrary to the Brake Hypothesis, batsmen produced significantly greater peak eccentric ER force than bowlers (184.20 ± 23.11 N vs. 121.25 ± 40.49 N; $p = .021$, $d = 1.98$). A high prevalence of bilateral ER asymmetry was observed, with 78% of athletes exceeding the 10% threshold and 56% exceeding the 15% threshold. No significant correlation was found between peak eccentric ER force and arm angular velocity ($\rho = 0.117$, $p = .765$).

Conclusions

This pilot study provides the first eccentric shoulder strength profile of elite Hong Kong cricketers and challenges prevailing assumptions regarding bowling-specific adaptations. The high prevalence of bilateral strength asymmetry highlights a potentially modifiable injury risk factor. Findings support routine quantitative monitoring and targeted eccentric training, particularly for bowlers. Larger longitudinal studies using velocity-specific protocols are recommended.

Keywords: *Shoulder Strength, Cricket, Bilateral Asymmetry, Eccentric External Rotation*

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Student Research 2 – Poster/Infographic

Eccentric Force Profiling and Bilateral Asymmetry in Elite Professional Male Cricketers: A Cross-Sectional Pilot Study

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Author: Chung Yu Ming , Dr Luk Tsz Chung & Mr Wong Tsz Sing

Background

- Cricket fast bowling : ↑ **Shoulder eccentric demands**
  - particularly: follow-through phase
  - posterior rotator cuff: rapidly decelerate the bowling arm at angular velocities exceeding over 2,000°/s (Seroyer et al., 2010).
- The "**Brake Hypothesis**" (Niederbracht et al., 2008) predicts:
  - bowlers: repeated arm deceleration → develop superior eccentric external rotation (ER) capacity.
- Despite: shoulder injuries → player unavailability (Orchard et al., 2016), normative eccentric force data in elite cricketers remain scarce.

Purpose

Cross-sectional profile (elite professional male cricketers: China Hong Kong national team):

- Eccentric rotational force characteristics
- Bilateral strength asymmetry
- Positional differences (bowlers vs. batsmen)

METHODS

PARTICIPANTS

9 Elite Male Cricketers
China Hong Kong National Team

BOWLERS n=4 | BATSMEN n=5

*All-rounders categorized as batsmen

Standardized 15-min warm-up

TEST 1: LOWER LIMB DECELERATION	TEST 2: BOWLING ARM VELOCITY	TEST 3: SHOULDER ER/IR FORCE
Equipment: 1080 Sprint	**Equipment:** Noraxon IMU	**Equipment:** 1080 Cable, 60°/s
Protocol: 15-m sprint + brake	**Protocol:** 3 maximal	**Position:** 90° abduction, 90° elbow
Outcome: Peak deceleration force (N)	**Sensor:** Distal forearm	**Protocol:** 3 max trials per side
Quality: ICC > 0.90	**Outcome:** Peak angular velocity (deg/s)	**Outcome:** Peak ER & IR force (N)
	Quality: Validated upper-limb kinematics	**Quality:** ICC = 0.90–0.96
(Rakovic et al., 2022)	*(Lazarus et al., 2017)*	*(Edouard et al., 2011)*

2-min rest between trials

STATISTICAL ANALYSIS

Software: SPSS v28 | α = .05
Methods: t-tests | Cohen's *d*
Asymmetry = [(Dom - Non-Dom) / Dom] × 100%
Thresholds: 10% moderate | 15% elevated risk
(Wilk et al., 2011)


Figure 1. IMU

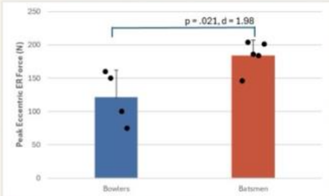

Figure 2. Calibrate Sensor


Figure 3. Bowling

Results

FINDING 1 — POSITIONAL DIFFERENCE

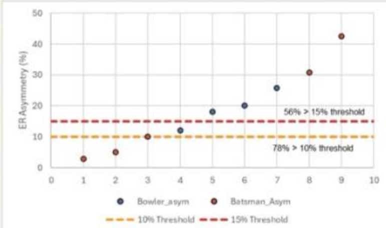
Batsmen demonstrated **significantly greater** peak eccentric ER force than bowlers, contrary to the Brake Hypothesis (Niederbracht et al., 2008).



Bowlers: 121.25 ± 40.49 N
Batsmen: 184.20 ± 23.11 N
p = .021* | d = 1.98 (very large)

FINDING 2 — BILATERAL ASYMMETRY

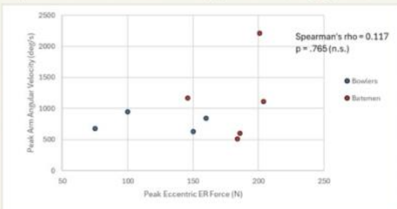
A **high prevalence** of bilateral ER asymmetry was identified across the cohort (Wilk et al., 2011).
- 78% exceeded the 10% threshold
- 56% exceeded the 15% threshold
- ER asymmetry > IR asymmetry pattern, consistent with overhead sport literature (Ellenbecker & Cools, 2010)



Orange: 10% Threshold
Red: 15% Threshold

FINDING 3 — FORCE-VELOCITY DISSOCIATION

No association between peak ER force and peak arm angular velocity.
- Spearman's rho = 0.117 | p = .765 (negligible)



Athletes with the highest force were not those with the highest arm speeds

Discussion

BRAKE HYPOTHESIS CHALLENGED

Bowlers (predicted) ✗ | **Batsmen** (observed) ✓

Effect size: *d* = 1.98

Resistance training | Workload fatigue | Task specificity

→ Bowling alone may not maximize ER force

(Niederbracht et al., 2008; Suchomel et al., 2016)

FORCE ≠ VELOCITY

ER Force - - ✗ - - Velocity

ρ = 0.117, *p* = .765 (n.s.)

- Distinct neuromuscular qualities
- Force ≠ RFD ≠ neural efficiency

→ Velocity-specific assessment needed

(Cormie et al., 2011; Maffiuletti al., 2016)

ASYMMETRY MATTERS

78% of athletes exceeded 10% threshold

56% of athletes exceeded 15% threshold

- Modifiable injury risk factor
- Cricket-specific validation needed

→ Routine quantitative monitoring warranted

(Wilk et al., 2011; Clarsen et al., 2014)

Practical Application

- Routine quantitative Sh. rot. force screening & workload-controlled testing conditions:
  - ✓ targeted eccentric strengthening
  - inform: multifactorial return-to-sport decisions.

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Student Research 3 – Abstract

The Correlation Between Power Outputs in Flywheel-based Upper Limb Rotational Movements and Golf Clubhead Speed in Amateur Golfers

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Background

Clubhead speed (CHS) is a key determinant of driving distance in golfers across all skill levels. While numerous physical tests have been used to assess their relationship related to CHS, most fail to adequately replicate the rotational kinetic chain sequencing required in the golf swing. Flywheel-based testing has gained popularity due to its ability to mimic sport-specific movements and provide immediate feedback on power output. However, no previous research has examined the relationship between power produced during kneeling woodchop and golf swing performance in amateur golfers. The purpose of this study was to investigate the associations between power output during three variations (high to low, low to high, horizontal) of the kneeling woodchop and driver clubhead speed in amateur golfers.

Methodology

Fifteen recreational male amateur golfers (18–40 years of age), free from recent upper-limb or lower-back injuries, participated in this cross-sectional study. Rotational power was measured during high-to-low, horizontal, and low-to-high kneeling woodchops using a flywheel device (kPulley Pro) at 3 different inertial loads. Driver CHS was assessed using two-dimensional high-speed video analysis (≥240 fps) with Kinovea software during 10 maximal-effort swings.

Results

Very large to moderate statistically significant correlations were found between all flywheel-derived power variables and CHS ($r = 0.608$–0.894, $p < .001$–$.016$). The high-to-low woodchop variation produced the highest power outputs and demonstrated the strongest associations with CHS. Concentric peak power during the high-to-low woodchop showed the strongest relationship ($r = 0.894$, $p < .001$, $R^2 = 0.724$).

Conclusion

These protocols are practical, time-efficient, and cost-effective. They can be readily implemented by golf coaches and strength and conditioning professionals to assess and train amateur golfers, offering a valuable tool for enhancing and monitoring rotational power and driving performance.

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Student Research 3 – Poster/Infographic

THE CORRELATION BETWEEN POWER OUTPUTS IN FLYWHEEL-BASED UPPER LIMB ROTATIONAL MOVEMENTS AND GOLF CLUBHEAD SPEED IN AMATEUR GOLFERS

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BACKGROUND

Clubhead Speed is Important

Current Tests Lack

Driving Distance & Golf Performance

Replica of Core Rotation Movement

METHOD

Examine the correlation between peak power outputs during three flywheel-based kneeling rotational woodchop variations (high-to-low, horizontal, and low-to-high) and driver clubhead speed in 15 amateur golfers (age 18-40 years).

Study Protocol Overview

SESSION 1

1. Standardised dynamic + flywheel warm-up
2. 10 max driver swings recorded for clubhead speed
3. Individual inertia profiling on the flywheel

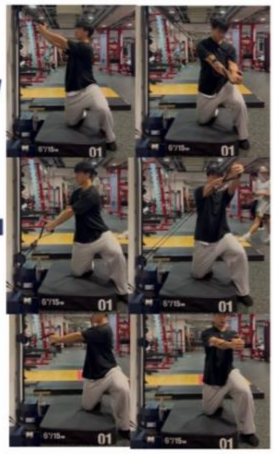
SESSION 2

1. Standardised dynamic + flywheel warm-up
2. 3 sets of 6 for three kneeling variations in randomised order

HIGH-TO-LOW

LOW-TO-HIGH

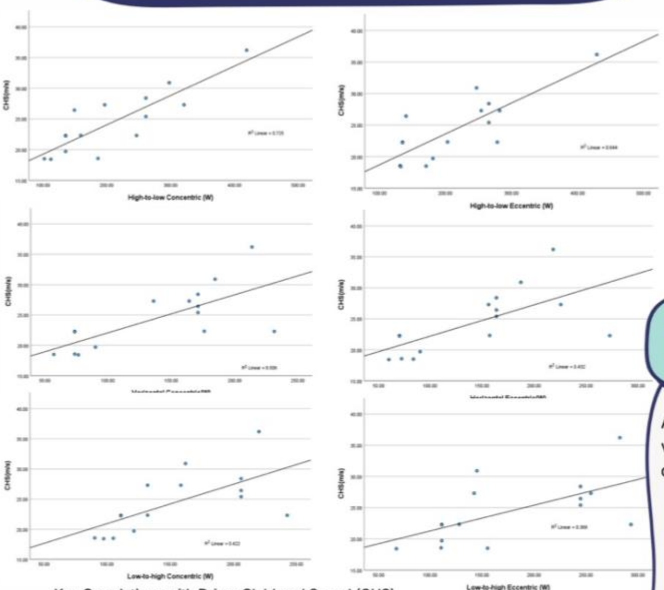
HORIZONTAL



RESULT

Descriptive Statistics for Kneeling Wood Chop Power Output and Golf Clubhead Speed

	Minimum	Maximum	Mean	SD
High-to-low Concentric(W)	102.13	419.00	207.91	90.68
High-to-low Eccentric (W)	131.20	429.00	216.60	83.44
Horizontal Concentric(W)	57.18	231.25	137.51	57.95
Horizontal Eccentric(W)	59.88	272.63	143.51	66.39
Low-to-high Concentric (W)	90.20	242.50	153.35	50.61
Low-to-high Eccentric (W)	67.13	293.13	176.19	75.52
Clubhead speed (m/s)	18.43	36.20	24.42	5.10



Key Correlations with Driver Clubhead Speed (CHS)

- High-to-Low Concentric Power: $r = 0.851$, $p < .001$, $R^2 = 0.724$ (strongest correlation)
- High-to-Low Eccentric Power: $r = 0.803$, $p < .001$, $R^2 = 0.645$
- Horizontal Concentric Power: $r = 0.711$, $p = .003$, $R^2 = 0.506$
- Horizontal Eccentric Power: $r = 0.657$, $p = .008$, $R^2 = 0.432$
- Low-to-High Concentric Power: $r = 0.649$, $p = .009$, $R^2 = 0.421$
- Low-to-High Eccentric Power: $r = 0.608$, $p = .016$, $R^2 = 0.370$

DISCUSSION

All three flywheel-based kneeling rotational woodchop variations demonstrated statistically significant positive correlations with driver clubhead speed in amateur golfers.

- This strongly supports the principle of movement specificity, as the high-to-low variation closely replicates the primary acceleration vector of the golf downswing.
- Individualised inertia profiling further enhanced the ecological validity of the power measurements.
- These results highlight that upper-body and core rotational power is a key performance limiter among amateur golfers.